BIOFUELS From Corn to Cellulose
consider the policy issues

With widespread public and political support for independent and clean sources of energy, the national focus will turn to western and eastern forests, and to the farms of the Midwest to supply biomass for fuel production. Iowa is already a leader in ethanol technology. Our favorable climate and soils, combined with production know-how and investor interest positions Iowa to maintain leadership in meeting our country's energy needs.

Iowa's capacity to deliver corn-based ethanol has been rapidly expanding. Figure 1 shows Iowa has the capacity to produce 1.6 billion gallons of ethanol per year from already constructed plants[1], and an estimated capacity in excess of 5 billion gallons per year from plants currently under construction, expansion or in the planning process.[2]

Concern is growing that Iowa may not have enough corn acres to supply this growing ethanol plant capacity. Additional corn supplies will come primarily from switching soybean acres to continuous corn production. However, some corn acreage will be added by converting marginal pasture and former cropland into crop fields.

Since using the entire 11 billion bushel U.S. corn crop for ethanol production would only provide 15 to 20 percent of the transportation fuel needed per year, the federal government is giving priority to developing technologies to make cellulosic ethanol practical and competitive. Once this technology is developed, the U.S. will depend heavily on supplies of cellulose including cornstalks, wood waste and dedicated energy crops like switchgrass to fuel ethanol plants and to produce biofuels. Being the leading supplier of corn grain-based ethanol in the United States will help, but not ensure, Iowa's ability to develop potential cellulose sources. For present and future Iowans, we must do it right.

The Iowa Department of Natural Resources supports ethanol development from both corn and cellulosic sources. However, as a state, Iowa must also consider all our natural resources and their role in building a sustainable economy. How can we plan to meet the nation's energy needs without depleting the natural resources that make Iowa third in the nation in production of agricultural products? Let's consider some of the potential effects of biofuel production on Iowa's natural resources.

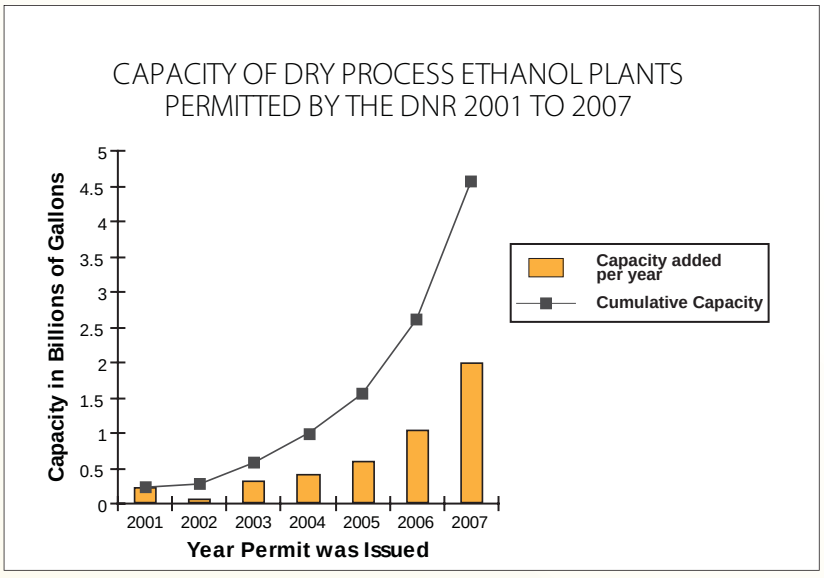


Figure 1

1. Planned and current ethanol production figures are from the Iowa Renewable Fuels Association Web site at http://www.iowarfa.org/
2. Planned capacity is calculated from Air Quality permit applications.

SOIL

With high corn prices, more land is expected to go into corn production. Additional corn supplies will come primarily from switching soybean acres to continuous corn production. Continuous corn is likely to increase fall tillage, resulting in more erosion. Continuous corn is also likely to increase fertilizer and pesticide use in an attempt to avoid the yield reduction associated with corn following corn.

Some additional corn acreage will be added by converting marginal pasture and Conservation Reserve Program or CRP fields to crop fields. Most CRP and pasture acres are located on steeper, more erosive and less productive soils. Switching CRP to corn production is expected to increase erosion and use of fertilizers and pesticides.

For example, modeling done in the Rathbun Lake Watershed indicates that converting the most erosive 29 percent (or 14,738 acres) of the existing CRP land (just four percent of the entire watershed) from permanent cover back to row crops will increase erosion by 204,000 tons per year. This is approximately four times the acceptable level of annual erosion.

As the demand for cellulosic ethanol production increases, it's unclear how long-term soil sustainability will be affected. One factor to consider is the removal of crop residues and the resulting decrease in organic matter.

Policy Questions

1. How much crop residue can be removed from fields while still returning sufficient organic matter to the soil to protect long-term productivity?
2. What is the best time of year to remove residue – fall or spring?
3. Is conversion of highly erodible land from permanent cover to cropland economically feasible or desirable?
4. What policies could discourage the most vulnerable soil from being returned to production?

WATER QUALITY

As erosion increases, whether from increased tillage or the conversion of CRP acreage and marginal pastureland to corn production, so does sediment delivery to Iowa's waters.

Again, in the Rathbun Lake Watershed, converting just 29 percent of the most vulnerable CRP acreage back to row crops will increase sediment delivery to the lake by 61,172 tons, adding about 6,200 dump truck loads of sediment to the lake each year.

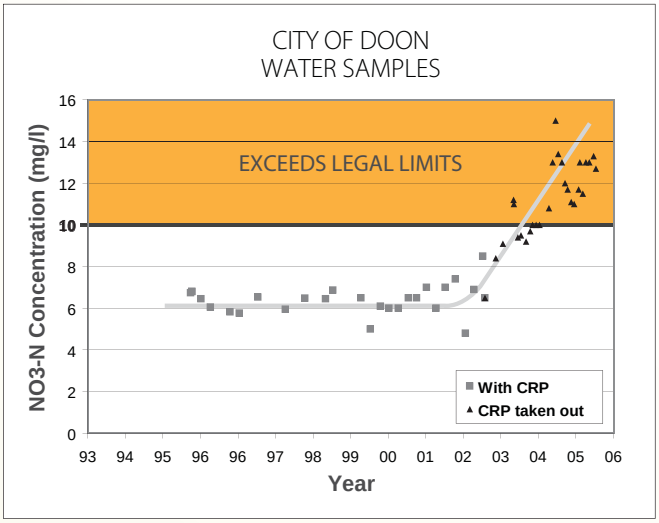


Figure 2

Similarly it would increase phosphorus delivery, stimulating algae growth. Should this occur, the added sediment is expected to negate millions of dollars spent in water quality improvements at Rathbun Lake and decrease the life of the reservoir.

Parallel concerns exist for nutrients. Figure 2 shows concentrations of nitrate levels in the City of Doon's drinking water supply. Preliminary results indicate that removing CRP from the wellhead area greatly affected groundwater nitrate concentrations, increasing them to above the maximum contaminant level (MCL).

Water quality can also be a concern when water used in ethanol and biodiesel plants is returned to surface water. Any discharge, whether overflow from a holding pond, cooling system or processed waste system, has the potential to impact fish and aquatic life. Discharge limits should prevent detrimental effects on water quality.

Another potential threat to water resources occurs when valuable ethanol byproducts, usually called distillers grain (DG), are used in livestock rations. These DG byproducts are high in phosphorus and may lead to increased risk of phosphorus runoff from manured croplands if not managed properly.

Policy Questions

1. What are the environmental and water quality costs of converting marginal pastureland and CRP acres to row crops?
2. What are the water quality results from increased phosphorus application through feeding DG to livestock?
3. What are the environmental and water quality costs of not having the appropriate permits and plans in place?

WATER QUANTITY

Groundwater is a valuable resource. Groundwater quality and quantity generally decrease from East to West and from North to South across the state. Ethanol production requires significant volumes of water, typically from groundwater sources (see figure 3). Water requirements vary, but roughly four gallons of water are needed to produce each gallon of ethanol. A100 million gallon per year ethanol refinery needs the same amount of water required by a municipal utility serving a population of 10,000.

As of December 2006, Iowa's ethanol plants had a total capacity estimated at more than 5 billion gallons per year once plants under construction, expansions and planned operations2 are completed. More than 20 billion gallons of water per year, largely from groundwater, will be required for plant operations.

WATER QUANTITY (CONT)

Ethanol production is the newest, but only a relatively small part, of our statewide water usage. Iowa's municipal and rural water systems use about 136 billion gallons of water per year and our livestock industry uses about 40 billion gallons of water annually, with 70 to 75 percent supplied by groundwater. While much of this water is returned to rivers and not "consumed," it is not returned to underground aquifers to replenish groundwater supplies.

Information and processes for managing our water supplies have not received adequate attention for many years. Demands for ethanol have brought this to light, as they present a rapidly growing challenge for our water management and allocation programs.

Livestock production also requires large amounts of water, and it is often a complementary industry to ethanol production. Feedlots may attract packing plants, and demands for corn may fuel interest in irrigation. Caution is urged in siting ethanol plants to protect water supplies of communities and the investment in the plants themselves.

Policy Questions

1. Should Iowa update water resources data, some which is now 20 years out of date, including assessing groundwater sources, and better monitoring trends in groundwater levels and stream flows?

2. What kind of data is needed to improve our groundwater allocation process and ensure that our water supply, and the economic growth it supports, is sustainable for the long term?

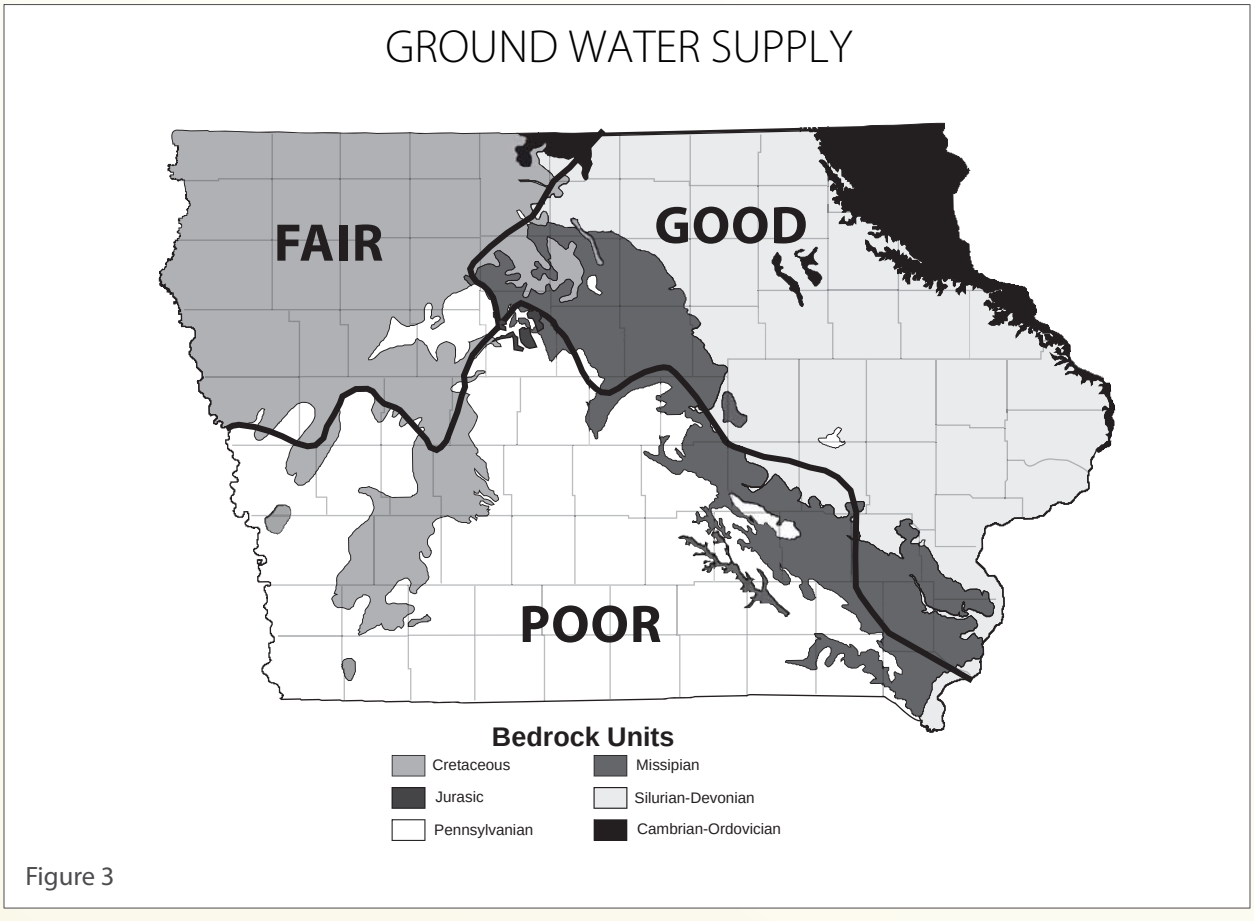


Figure 3

AIR

Iowa has clean air and currently has no violations of the National Ambient Air Quality Standards. This is important to businesses as it reduces their environmental costs and makes them more competitive. Iowa needs to keep its air quality good to maintain our current level of air quality regulation.

Small communities (and many large ones) are generally unaware of limits on our clean air resources set at the federal level by the U.S. Environmental Protection Agency. Air permits are issued by the state DNR to ensure that new and existing industries do not use up a limited clean air resource and exceed the National Ambient Air Quality Standards. If those resources are "used up," the community cannot add additional industries or other sources of air pollution that impact the same areas at ground level. Emission reductions in future permitting would be required.
With the rapid expansion of ethanol and biofuel plants in the state there are other issues that need to be addressed early in the planning process to ensure compliance with applicable regulations. The following scenarios where more stringent regulations could apply should be considered:

• Plants that are co-located with other industrial or agricultural facilities such as grain elevators may be considered one regulatory unit if materials are moved between facilities, even when the facilities have different owners.
• Facilities that request setting emission limits too low to avoid more stringent regulations and are not being able to meet those limits .
• Facilities that begin operation as minor sources and quickly apply for permits to expand -- the original project plus the expansion may be treated as one project.

Also, increased traffic on rural, gravel roads increases fugitive dust, which is a concern for residents living in the vicinity of ethanol plant transportation routes.

Policy Questions

1. How can communities work with biofuel plants to ensure that a limited clean air resource is not used up?
2. What types of alternative, low emission energy sources could be used to fuel the plants?
3. How do we address other air quality impacts, such as those from increased transportation?

PLANTS

As demand for ethanol (corn and cellulosic) grows there will be pressure to convert existing natural habitats to produce ethanol. These natural habitats are exceedingly rare in Iowa (less than 1 percent of original prairie, 5 percent of marshland and 20 percent of original forested acres remain). They cannot be replaced. They are home to more than 1,500 native plant species that support a diverse wildlife population. They also have aesthetic, scientific and other values that we probably haven't yet identified. And, in many cases they are in areas that were too difficult or too unproductive to convert to cropland.

Existing cropland with high corn suitability ratings, commercial timberland and hay or pasturelands may be a more efficient way to provide biomass than converting the few remaining natural habitats.

There are other concerns for the native plant community if genetically engineered biomass crops are used to produce cellulosic ethanol. As high yield, aggressive Roundup Ready biomass crops are developed (switchgrass, kenaf, miscanthus and hybrid poplar or willows) they could invade native habitats, destroying existing plant communities and associated terrestrial species.

Policy Questions

1. What incentives are needed to allow the use of non-production lands for biomass in a sustainable way?
2. How can incentives to encourage biomass production be structured that do not encourage the conversion of existing habitats?
3. How do we encourage landowners to keep marginal land in trees or grass to protect soil, water and wildlife?
4. Are there native, ecologically-appropriate plants that could be used for biomass in Iowa?

ANIMALS

Domestic
There is a potential to expand and concentrate dairy and beef cattle near ethanol plants in order to use the distillers grain byproducts. There is also the potential to increase the phosphorus content in the animal manures.

Iowa's recently revised open feedlot rules will aide in the design and siting of large cattle feedlots (capacity of 1,000 or more head). Nearby natural resources should be protected from adverse impacts as the new rules are fully implemented and enforced. However, smaller open feedlots that are not as directly affected by the new rules may need additional assistance to protect water quality.

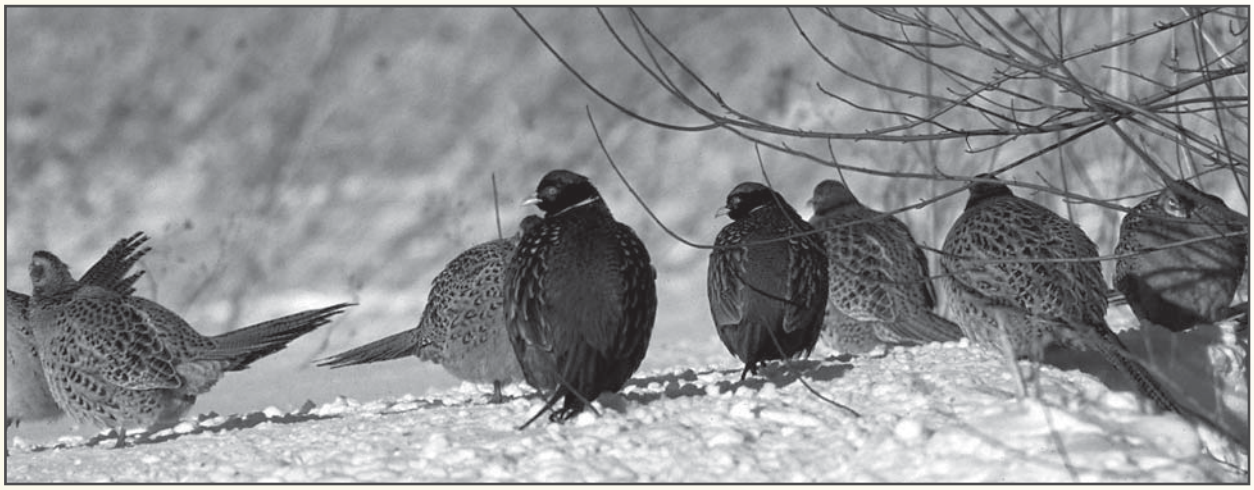
Wildlife
There have been some proposals to eliminate the general Conservation Reserve Program (CRP) in Iowa to increase corn production. If the 1.4 million acres of general CRP in Iowa were converted to crop production, pheasant populations are estimated to decline by 55 percent or more. Iowa is currently one of the top destinations for pheasant hunting in the Midwest. As hunters move to other states or simply stop hunting, the economic impact on the state would be $90 million annually. Most of this loss would occur in rural counties.

The conversion of grasslands and CRP to cropland would also decimate the songbird population. While the decline of these species will not have the same economic impact as a decline in the pheasant population, many species of concern have stabilized as "permanent" grasslands have developed under the CRP program. The Henslow Sparrow and Northern Harrier are two examples of species that may become listed as threatened or endangered if CRP is lost. If CRP is retained to produce biomass, but converted to a monoculture such as switchgrass it will not produce as much wildlife as diverse grass mixtures.

Similar but less known impacts can be predicted for many species of reptiles and amphibians as their habitat is converted to cropland.

Policy Questions

1. Will there be adequate technical and financial assistance available to smaller feedlots?
2. Are there additional needs for manure management or open feedlot run-off controls?
3. What policies could mitigate the impacts to wildlife as CRP acres are lost across Iowa?
4. What impact will the loss of additional grassland have on wildlife and the recreational opportunities and the associated economy in rural communities?
5. Can dedicated biomass crops (switchgrass) be managed and harvested to also produce wildlife benefits?
6. Can incentives for biomass production be designed to promote diverse grass mixtures over monocultures?



ENERGY

Iowa imports 96 percent of energy used in the state. In addition to looking at the impact of ethanol plants on other natural resources, it is important to consider energy inputs and outputs and the potential to increase plant efficiency

The critical energy source for modern ethanol plants is natural gas. About 20 percent of all natural gas used in Iowa is used for ethanol production, with 3.5 percent used to grow the corn and the rest used to fuel the plants and dry the distillers grain. Given the expansion of ethanol production in Iowa, natural gas usage for ethanol production is growing dramatically. (About 40 percent of the total used in plants is for drying grain. Drying is the part of the process that causes more emissions, affecting air quality.)

While some of the distillers grain byproducts are used for cattle fed in Iowa, about 75 percent of the distillers grain is shipped out of state, adding to transportation and fuel costs.

Alternative sources of energy for ethanol plants include coal, biomass and biogas. Biomass can consist of the distillers grain byproducts from the first step in ethanol production as well as other cellulosic sources such as corn stalk residue, switchgrass, and wood chips. Biogas is the methane recovered through the anaerobic co-digestion of thin stillage, distillers grain, livestock manure, food processing wastes, glycerin from biodiesel production and other organic wastes. While combustion of coal adversely affects air quality, biomass and biogas have the potential to increase energy efficiency and provide cleaner burning.

There is great potential to increase energy efficiency by taking advantage of biomass and biogas as energy sources for the plants, replacing or augmenting the use of natural gas. Most plants today use a process that converts fossil fuel (primarily natural gas, but also diesel/gasoline) to produce ethanol with an average energy gain of 1 to 1.3. Using renewable energy sources such as biomass can improve energy efficiency to a ratio of 1 to >10. By combining heat and power technologies and using methane gas from a closed loop production system, it's possible to increase the energy efficiency to 1 to 46.

Farm management practices also play a key role in achievement of energy efficiency. Managing nitrogen (particularly anhydrous ammonia made with natural gas) could provide significant energy savings for the state. For example, if corn production in Iowa was increased by 1.2 million acres and these acres were

ENERGY (CONT)

fertilized at 200 pounds of nitrogen per acre, an additional 240 million pounds of nitrogen would be applied to the land, with significant amounts ending up in our water. If the fertilizer rate were dropped to 140 pounds of nitrogen per acre, nitrogen application could be reduced by 72 million pounds.

If crop producers use no tillage and other forms of conservation tillage, even more significant energy savings can be realized. For example, most Iowa farms could save 44 percent of diesel fuel by using no tillage instead of a conventional tillage method. On 100 acres of corn, that amounts to a savings of 221 gallons of fuel over the conventional tillage which would consume 498 gallons. If that fuel savings is expanded to the additional 1.2 million acres of corn that Iowa could supply3, a savings of 2.7 million gallons of diesel fuel could be saved.

3. Center for Agricultural and Rural Development.

Policy Questions

1. How can we replace natural gas with Iowa-grown energy sources?
2. How will renewable energy inputs into the ethanol production process impact air and water quality?
3. What additional incentives are needed to encourage ethanol production facilities to incorporate energy efficiency and renewable energy technologies into their production processes?
4. What is the future of distillers grain in Iowa?
5. How can Iowa encourage increased value for distillers grain?
6. How can we encourage energy conservation in agricultural production?

SUMMARY

Iowa is a leader in corn-based ethanol production and has the production know-how, investor interest and natural resource capacity to be a leader in cellulosic ethanol production as well. As cellulosic ethanol gains prominence, we have the opportunity to ask the right questions and provide the resources to maintain our leadership. For present and future Iowans, we must do it right.

Policy Questions

What additional resources and research are needed to adequately meet the technical demands for assistance and environmental protection as Iowa maintains leadership in meeting our country's energy needs?